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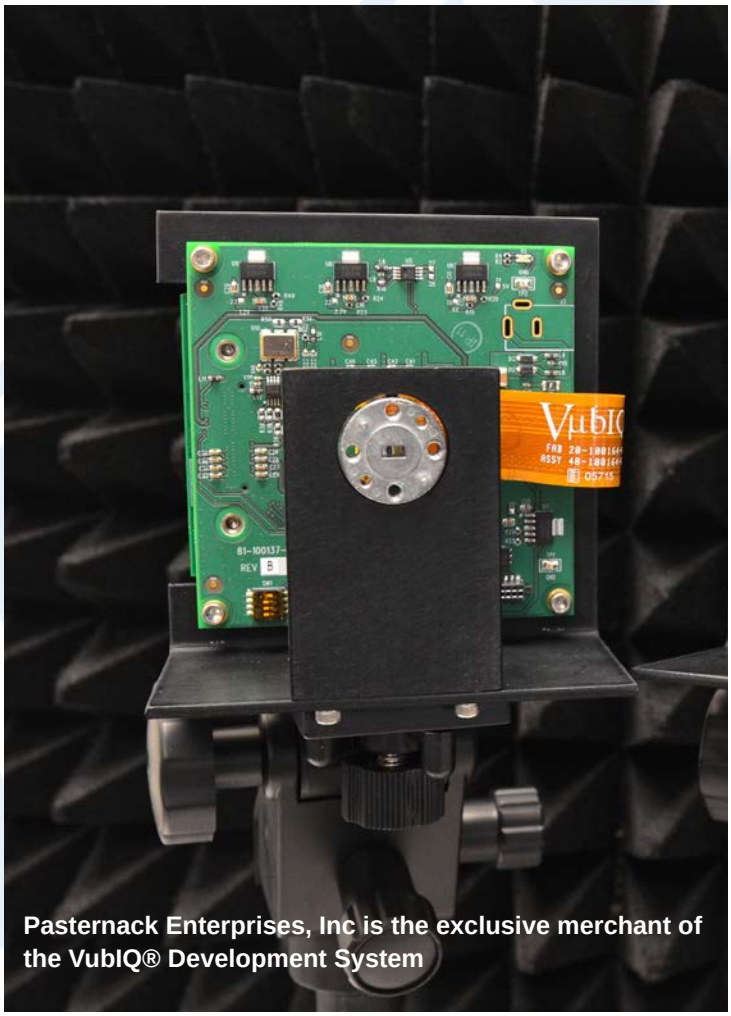
THE ENGINEER'S RF SOURCE

60 GHz Transmit (Tx) Development System

USER GUIDE PEM009-KIT-TX

Development System Features

- Easiest way to interface with the waveguide modules
- Coaxial baseband connections using MCX and SMA cables
- Power supply voltages provided
- Reference clock provided
- Separate Tx board, brackets, tripods
- USB cables for PC - 5V power is derived from USB
- GUI software for easy configuration and module control



Pasternack Enterprises, Inc is the exclusive merchant of the VubIQ® Development System

Click the following link (or enter part number in "SEARCH" on website) to obtain additional part information including price, inventory and certifications: 60 GHz Transmit (Tx) Development System PEM009-KIT Transmit

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60 GHz Transmit (Tx) Development System

USER GUIDE PEM009-KIT-TX

Datasheets / Software

Data sheets for the Development System and the Trasmitter/Receiver waveguide modules are available at:

www.pasternack.com

The specific links are:

User Guide (this document):	http://www.pasternack.com/images/ProductPDF/PEM009-KIT.pdf
Development System GUI (1.95):	http://www.pasternack.com/images/ProductPDF/PEM009-KIT_60_GHz_Dev_System_GUI.zip
Trasmitter Waveguide Module (PEM010):	https://www.pasternack.com/images/ProductPDF/PEM010.pdf

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60 GHz Transmit (Tx) Development System

USER GUIDE PEM009-KIT-TX

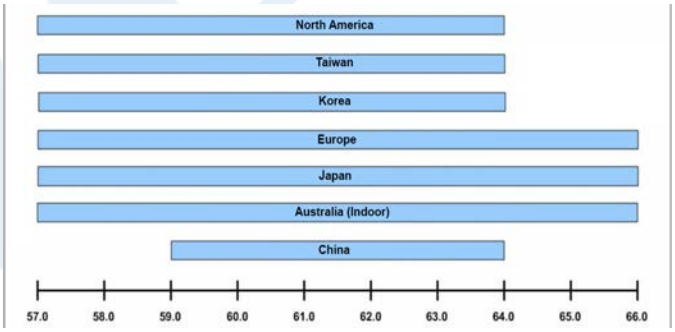
Overview

The PEM009-KIT development system is composed of a millimeter wave transmitter board that can be set up and operated using a PC via a simple USB interface on each board. The Tx board assemblies have built-in reference crystal oscillators (default) which exhibit very good phase noise performance. The Tx boards also support expansion ports if system level applications may involve the transmitter and/or receiver to be phase locked to an external source. This could involve a User designed baseband system or a programmable arbitrary waveform generator (AWG). The objective of the system is to enable 60 GHz experimentation and product development focused on the use of an integrated transmitter waveguide module and integrated receiver waveguide module with standard WR15/WG25 flange interfaces.

Board Assembly on Tripod

Waveguide Module

Potential applications range from multi-gigabit communications systems such as GigE wireless LAN, 802.15.3c, 802.11ad development, SDI video products, radar, and radiometery. The 60 GHz spectrum is now allocated as unlicensed in many countries world wide.



International Unlicensed Spectrum Allocation for the 60 GHz Band

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60 GHz Transmit (Tx) Development System

Development System Contents

The PEM009-KIT contains the following:

- Transmitter Waveguide Module PEM010
- Transmitter board (1)
- Board/waveguide module mounting bracket (1)
- Bench top tripod (1)
- USB cable (1)
- GUI software (downloadable from web site)
- Documentation and data sheets (downloadable from web site)
- MCX coaxial connector expansion board (1)
- Power Supply (1)
- Phased matched coaxial cables, MCX to SMA (4)

The transmitter and receiver boards are shipped attached to the mounting brackets. The brackets accept a standard ¼-20 thread fastener for use with included tripods.

Optional Accessories:

- **PEM004**: 60 GHz Baseband I/Q Module
- **PEM005**: 60 GHz Waveguide Module Flex Circuit Cable (Replacement)
- **PE9881-20**: WR-15 Waveguide Horn Antenna 50 GHz-75 GHz (20 dBi Gain)
- **PE9881-24**: WR-15 Waveguide Horn Antenna 50 GHz-75 GHz (24 dBi Gain)
- **PE9881-34**: WR-15 Waveguide Horn Antenna 56 GHz-66 GHz (34 dBi Gain)
- **PE9881-42**: WR-15 Waveguide Horn Antenna 50 GHz-75 GHz (42 dBi Gain)
- **PE-W15A001**: WR-15 Waveguide Horn Antenna 58 GHz - 63 GHz (0 dBi Gain)

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System Setup / Interconnection

The development system boards communicate with a PC (running the GUI software) using USB as the interface. Each board derives its power from the USB connection (standard operation). The control processor on each board communicates with the PC through the USB port.

Baseband signals are connected via the high speed baseband connector on the rear side of each board. The baseband connector is a Samtec QSE. The mating connector required is a Samtec QTE-020-01-L-D-A. The expansion board mounts onto the Samtec QSE connector and is attached to the main board with the suplied hardware, 2 x 4-40 socket head screws.

The expansion board transitions the QSE connector to a set of MCX coaxial connectors for baseband and optional external reference clock signals (see Figure 1). Also supplied with the expansion board is a set of eight phase-matched cables for baseband test equipment interconnection.

Figure 1 RF Board Rear View with Expansion Board Attached

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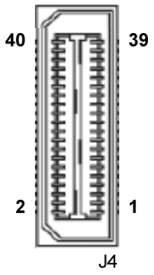


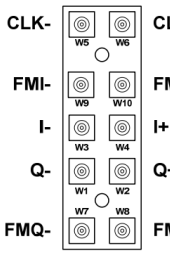
81-100135-000 RX Board
81-100134-000 TX Board

Connector J4:
Samtec QSE-020-01-L-D-A

Mating Connector:
Sametc QTE-020-01-L-D-A

Pin	Function	Pin	Function
1	GND	21	NC
2	GND	22	AUX_IO_0
3	TXFMQ-	23	NC
4	Q-	24	AUX_IO_1
5	TXFMQ+	25	GND
6	Q+	26	AUX_IO_2
7	GND	27	USB D+
8	GND	28	AUX_IO_3
9	TXFMI-	29	USB D-
10	I-	30	AUX_IO_4
11	TXFMI+	31	GND
12	I+	32	AUX_IO_5
13	GND	33	GND
14	GND	34	GND
15	NC	35	+5
16	EXT CLK -	36	AUX_IO_6
17	NC	37	+5
18	EXT CLK +	38	AUX_IO_7
19	NC	39	GND
20	GND	40	GND

High Speed I/O Connector Pinout



81-100136-000 Expansion Board

Connectors W1-W10:
MCX Receptacle

Mating Connector:
MCX Plug

MCX	Function
W1	TX/RX Q-
W2	TX/RX Q+
W3	TX/RX I-
W4	TX/RX I+
W5	EXT CLK -
W6	EXT CLK +
W7	TXFM Q-
W8	TXFM Q+
W9	TXFM I-
W10	TXFM I+

Expansion Board Connector Pinout

Figure 2 Baseband High Speed Connector and Expansion Board Connectors

Figure 2 shows the pinout of the high speed baseband connector and the expansion board coaxial connectors. For higher level system integration, direct connection via the Samtec high speed connector can be facilitated using the mating Samtec connector as shown.

A typical test set up is shown in Figure 3 below. Here the transmitter baseband source is either a user designed baseband system, or a programmable arbitrary waveform generator (AWG). A two channel AWG can create any form of vector modulation (I and Q baseband) with appropriate programming or selectable standard modulation formats (such as BPSK, QPSK, etc.). The receiver baseband scheme is again either user defined or a signal analysis test system.

By using a programmable AWG for the transmitter baseband source, user defined vector modulation schemes can be created along with various error correction coding, equalization testing, etc. Most AWG products available today work with MATLAB and other tools that provide a convenient method of baseband signal generation.

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GUI Control Software

As shown in Figure 3, the transmitter and receiver boards are set up and controlled from a host PC running the GUI software. The software can be downloaded using this link as a ZIP file. Unzip the files and place into a convenient directory on the PC that will be used with the development system test setup. With a transmitter and receiver board connected via the USB cables to the PC, run the software (VubiqGUI.exe). A transmitter window and a receiver window will appear showing the block diagrams. The transmitter board LED will illuminate red, and the receiver LED will illuminate blue.

Each GUI window provides the user with the ability to set up various control parameters for the transmitter and receiver boards. Board voltages and temperatures are also monitored. The window images are shown on the following pages, Figures 4 and 5.

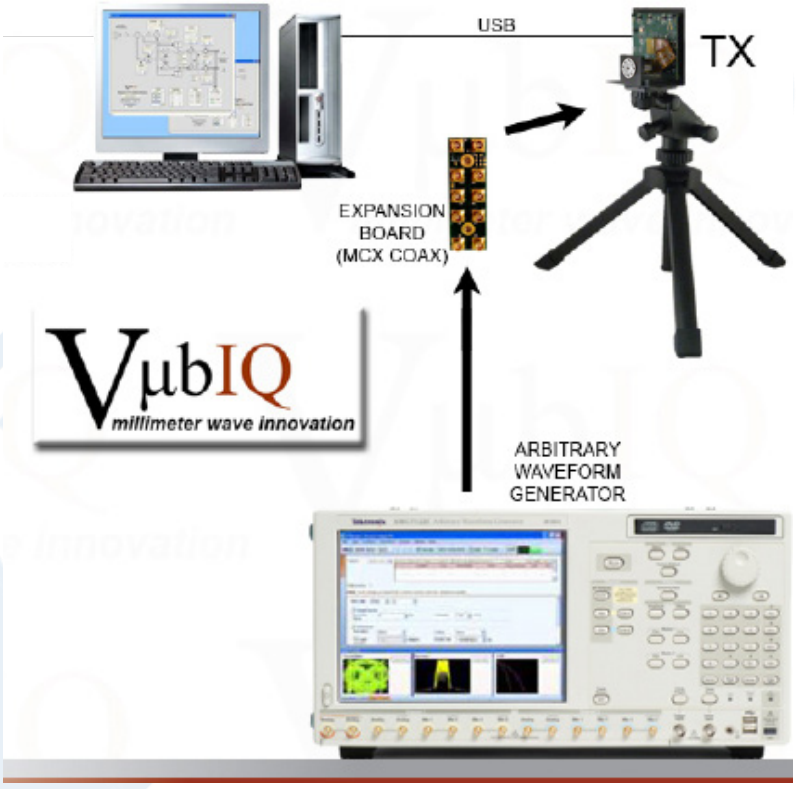

Figure 3 Various Test and Development Scenarios

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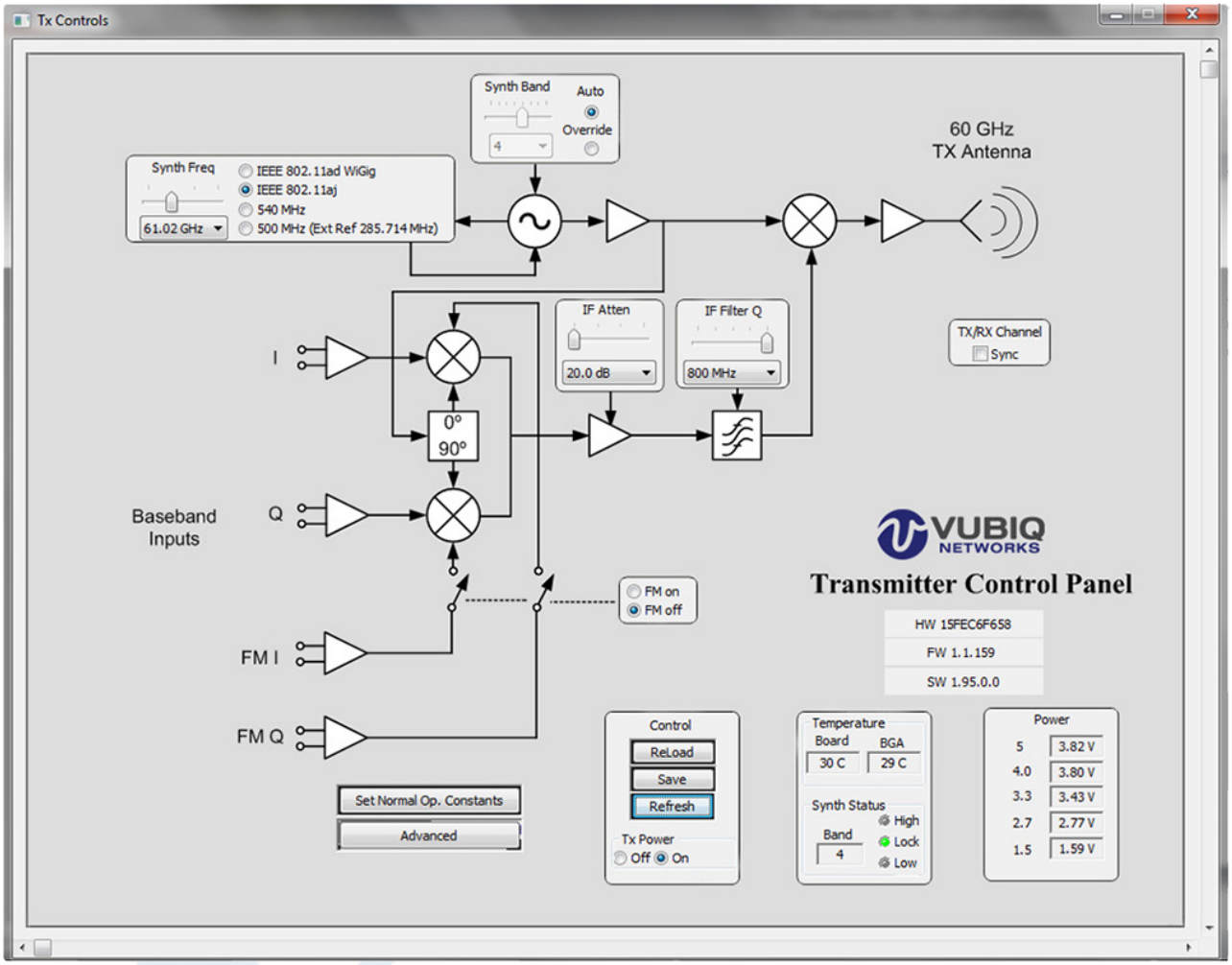

Figure 4 Transmitter GUI Window

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The window layouts are designed as intuitive block diagrams of the transmitter and receiver waveguide module circuits. There are separate boxes for control and monitoring functions. The following chart (Figure 5) shows the transmitter and receiver functions for each box.

Window Box	TX
Control	X
Temperature	X
Power	X
Baseband	
Synth Freq	X
Synth Band	X
IF Atten	X
IF Filter Q	X
FM on/off	X
AM/I-Channel	
FM/Q-Channel	
BB Filters	
BB Sig Short	
BB Atten	
I Atten Fine	
Q Atten Fine	
Baseband	
Serial Number/Firmware Version	X
Set Normal Op. Constants	X
Advanced	X

Figure 5

The window shown to the left is used to exit the GUI entirely and is generated when the GUI is initialized from the executeable. "Launch Tx Controls" button as this window is automatically launched by the GUI.

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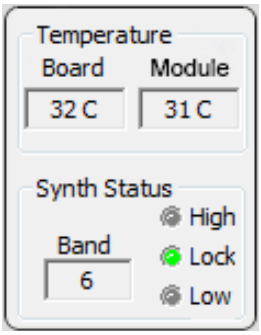
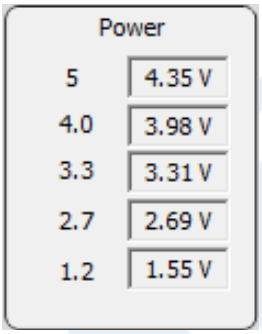
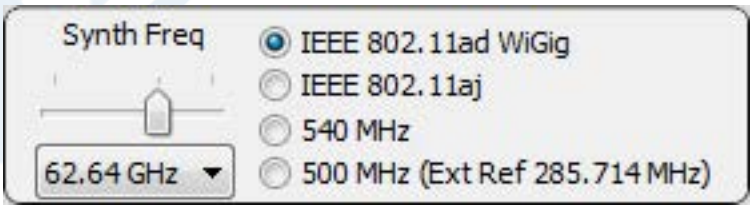


The Temperature/Synth box monitors the board temperature and the RF module temperature in ºC. The synth status section indicates the synthesizer lock status and the band tuning status.



Power supply voltages are monitored in this box. Note: the 5 volt supply is measured from the USB source and typically runs at about 4.1 to 4.4 V.



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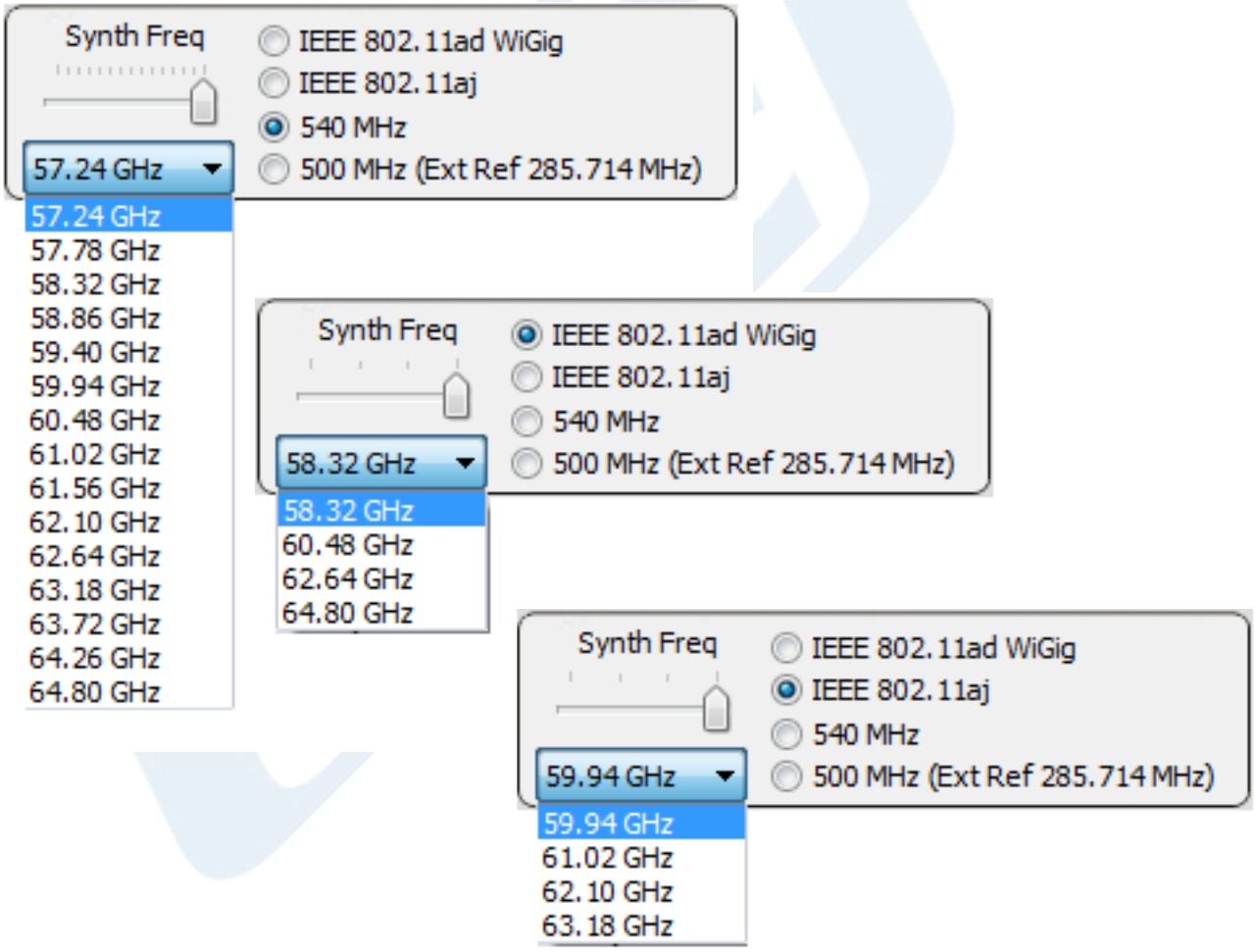
The module's operating frequency is set with the Synth Freq box shown above. This control sets the synthesizer digital divisor ratio in the RF module. The standard frequency range can be set from 57.24 GHz to 64.80 GHz in 0.54 GHz steps. Optionally, the RF modules can be set from 57.0 GHz to 64.0 GHz in 0.5 GHz steps with a reference oscillator clock of 285.714 MHz. The synth frequency box has pre-configured frequency subsets corresponding to 802.11ad/WiGig, 802.11aj, or fixed spacing at 540 MHz (optionally 500 MHz). The frequency can be selected with either the slider control or the drop down menu. Occasionaly, when selecting a frequency, the module may not respond to the first requested input. This can me remedied by selecting the desired frequency from the drop down menu a second time.



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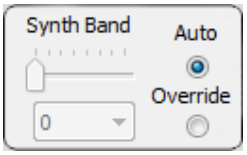
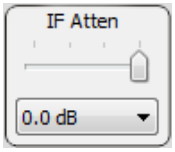
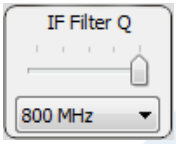


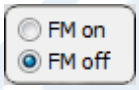
The Synth Band box is typically set in Auto mode, and will track the Synth Freq settings. This box allows separate tuning adjustment of the VCO tank circuit for experimentation (Override Mode).



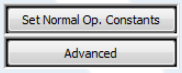
IF Atten box sets the IF attenuation for either the TX or RX board. The lower the attenuation level (in dB), the higher the gain setting. When this control is set to 0.0 dB, the IF gain is at maximum. The slider control or drop down menu can be used; there are 16 settings from 0 dB to 20 dB.



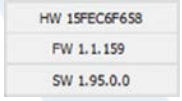
The IF Filter Q box is a coarse IF bandwidth control, providing highest Q (narrowest bandwidth) at 800 MHz, and lowest Q (widest bandwidth) at 1.2 GHz. There are 5 settings from 800 MHz to 1.2 GHz



The FM on/off control box (TX only) activates the additional FM switching modulators in the I/Q modulation stage. When selected, FSK type modulation can be set up by using the FMI and FMQ baseband signal inputs in conjunction with the I and Q signal inputs



These two controls, common to the TX, are used to reset the default register data to the RF modules (Set Normal Op. Constants) and to bring up a detailed RF module register screen (Advanced). [1]



Each transmitter board has a unique serial number (HW). Also, the firmware release version (FW) and the software release version (SW) are shown in the same box.

[1] The Advanced screen provides access to individual data registers for the RF modules. Changing these register values through the Advanced screen is not normally required since the GUI interface provides the most comonly used control functions.

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Reference Oscillator Source Options

The transmit boards come with built-in low phase noise crystal oscillators that provide the clock reference frequency for the TX synthesizers. The frequency of the on-board oscillator is 308.571 MHz (540 MHz channel spacing) and has a stability rating over temperature of 25 ppm. There may be certain system level applications that require the transmitter and/or receiver to be phase locked to an external source. Also, if 500 MHz channel spacing is desired, the external reference clock must be 285.714 MHz. The TX RF boards are set up to provide the following options for oscillator reference source:

1. Internal, separate crystal oscillators (default)
2. External 308.571 MHz or 285.714 MHz signal source such as a laboratory signal generator (0 dBm typical)
3. Transmitter sourcing the receiver (TX master) from the TX on board oscillator

The optional reference oscillator settings are implemented via zero-ohm resistor (or wire jumper) modifications on the TX RF boards as required. The schematics and pictures on the following pages are provided to illustrate the modifications for the desired settings (Figures 6 and 7).

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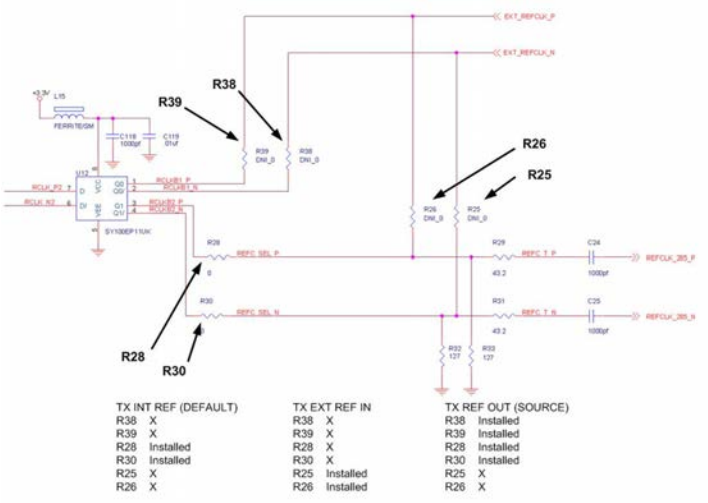

Figure 6 Transmit Board Reference Oscillator Configurations

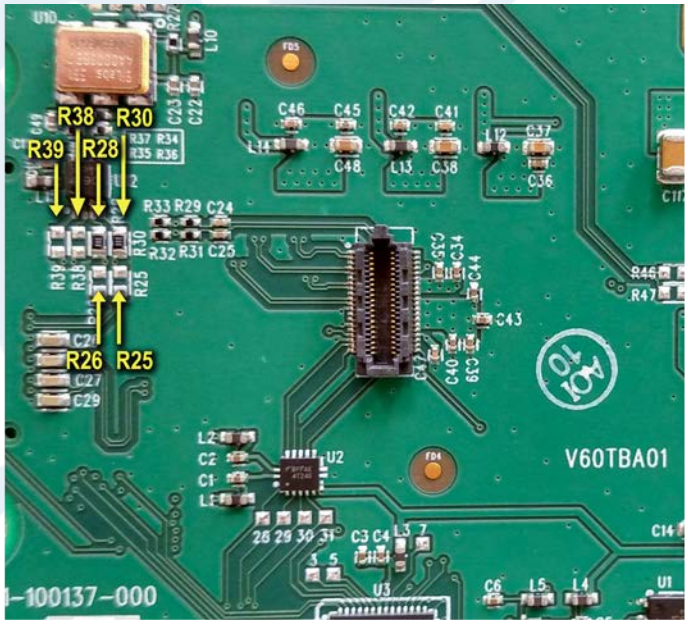

Figure 7 Transmit Board Reference Oscillator Resistor Locations

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Development System PEM009-KIT Antenna Selection Guide 60 GHz Link Budget Analysis w/ O2 Factor

Lab test	
Distance	PE Part Number
3 meters	PE9881-20
10 meters	PE9881-24

Outdoor test	
Distance	PE Part Number
100 Meters	PE9881-34
500 Meters	PE9881-42

60 GHz Link Budget with O_2 Attenuation Factor

	Freq	60	GHz	
	Oxygen	15	dB/km	
Tx Pwr	Tx Ant Gain	Rx Ant	Distance	Rcv Pwr
dBm	dBi	Gain dBi	m	dBm
5	20	20	3	-32.59
			9.8 feet	

PE9881-20

	Freq	60	GHz	
	Oxygen	15	dB/km	
Tx Pwr	Tx Ant Gain	Rx Ant	Distance	Rcv Pwr
dBm	dBi	Gain dBi	m	dBm
5	24	24	10	-35.15
			32.8 feet	

PE9881-24

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	Freq	60	GHz	
	Oxygen	15	dB/km	
Tx Pwr dBm	Tx Ant Gain dBi	Rx Ant Gain dBi	Distance m	Rcv Pwr dBm
5	34	34	100	-36.50
			328 feet	

PE9881-34

	Freq	60	GHz	
	Oxygen	15	dB/km	
Tx Pwr dBm	Tx Ant Gain dBi	Rx Ant Gain dBi	Distance m	Rcv Pwr dBm
5	42	42	500	-40.48
			3281 feet	

PE9881-42

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URL: http://www.pasternack.com/60-ghz-test-development-system-prm009-kit-tx-p.aspx

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